



Commercial Lunar Landing & Exploration Technologies

Aspire . Believe . Create

Lunar Science for Landed Mission Workshop

Thursday, 11 January 2018

Adithya Kothandhapani
Axiom Research Labs Pvt Ltd



Landing Mechanisms

Lander Touchdown Energy Absorption Systems for Lunar Landing.

Performance

- Lateral velocity < 1m/sec
- Longitudinal velocity < 3m/sec
- Slopes < 18deg
- Rotational rates < 1deg/sec.

Lunar Descent GNC

Scalable & robust architecture, for different classes of landing missions and budgets.

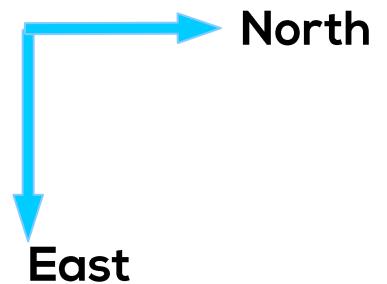
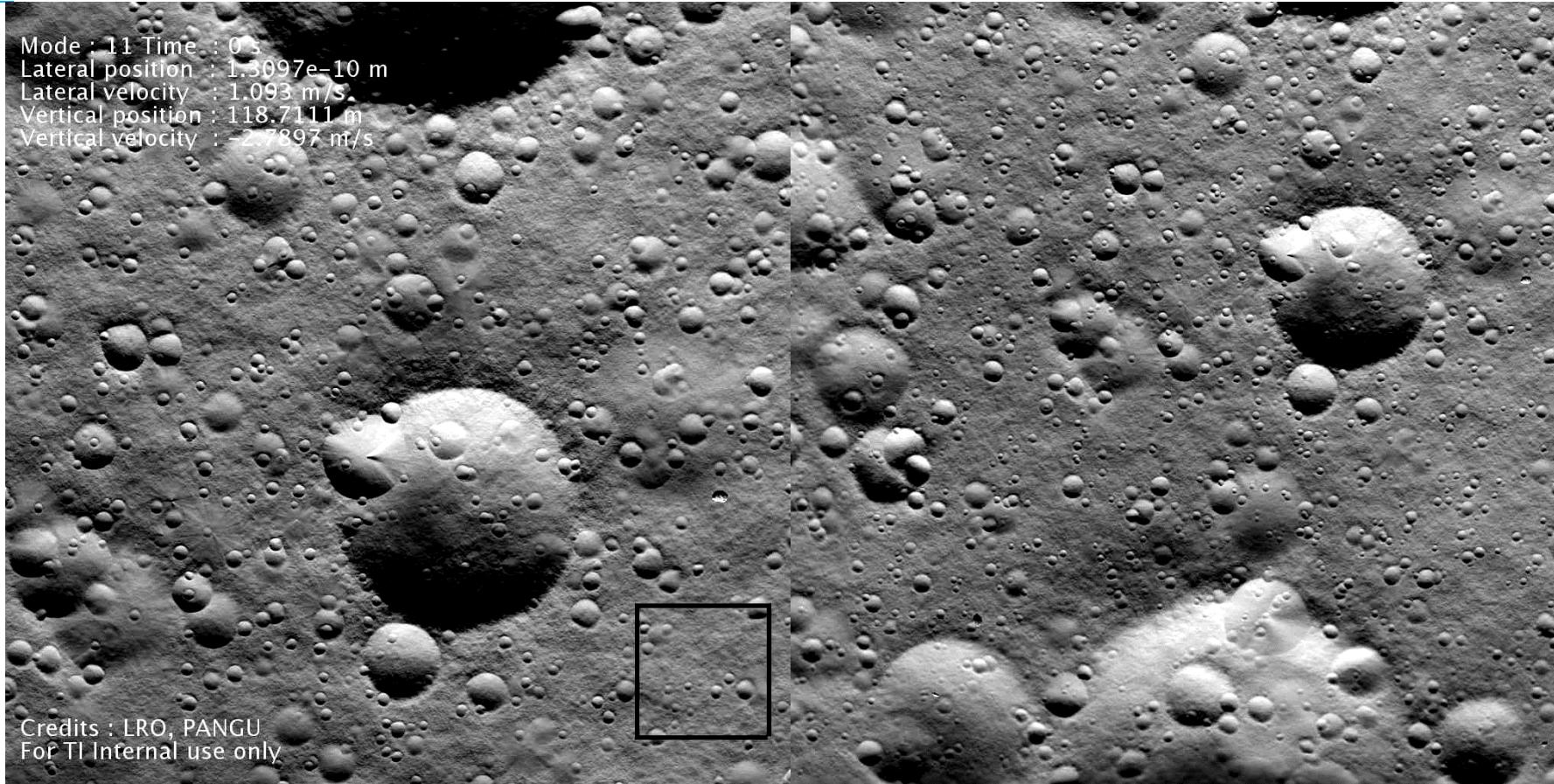
Current precision <100m
+ Safe Spot Detection

Improvements under development

- Improved landing precision:
 - Near-side < 50m
 - Far-side < 2km
- Sample return
- Enhanced payload capacity



Terminal Descent (Safe Spot Detection)

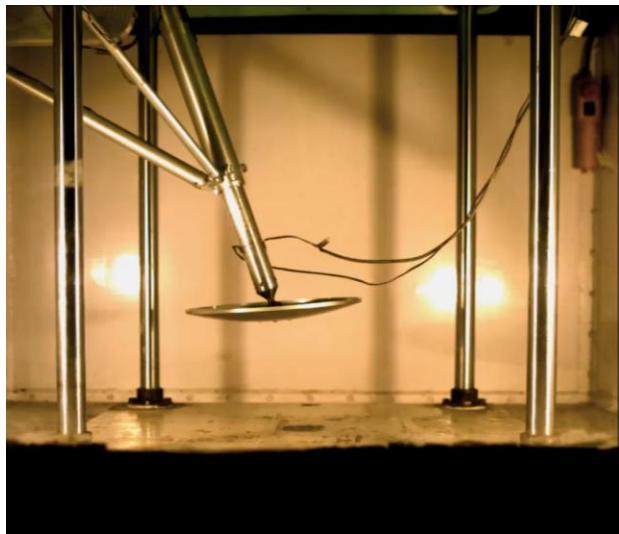


Perspective video
of soft landing
captured by Lunar
Descent Sensor
@6fps: Terminal
Descent Simulation
ARLTITrD-MC01291





Landing Gear Functional Test



Inclined Leg Vertical Drop Test



Landing Gear Qualification Test



Scaled (1/6) Model Drop Test

HHK-1

Lunar Lander

Mission	Lander – Rover
Developer & Operator	Axiom Research Labs – TeamIndus
Mission duration	Orbit : 28 days Surface : 10-14 days
Launch Mass	600kg (20kg surface payload)
Propulsion	Unified Bi-prop
Power	28V bus 240W (Solar), 24 Ah (Storage)
Communication	TT&C : 1kbps S-band (LGA) Payload data : 1Mbps X-band (HGA)



ECA

Lunar Exploration Rover

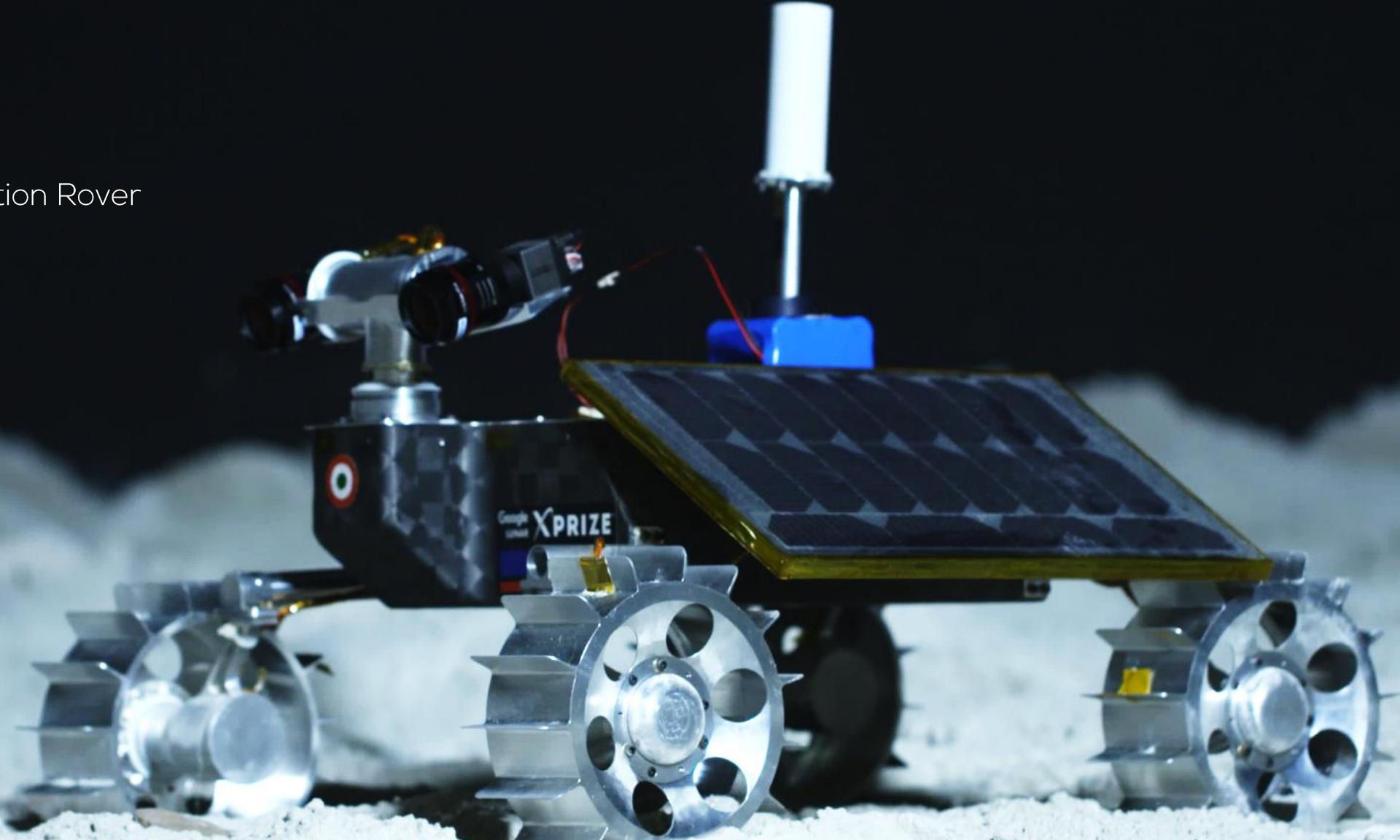
Mass	7kg
Locomotion	4-wheeled independent drive
Size	450mm x 450mm
Max slope gradeability	25deg
Static stability	45deg
Navigation	Stereo VO - Sun Sensor – IMU
Communication	250kbps (surface relay)
Speed	2 to 5 cm/sec





ECA

Lunar Exploration Rover

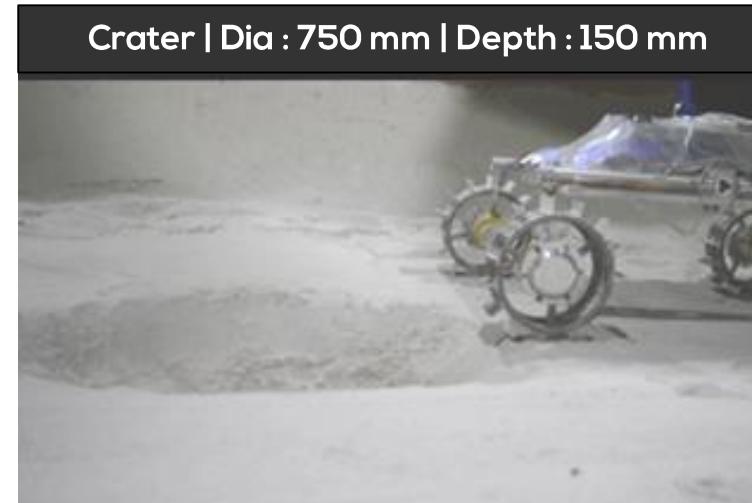




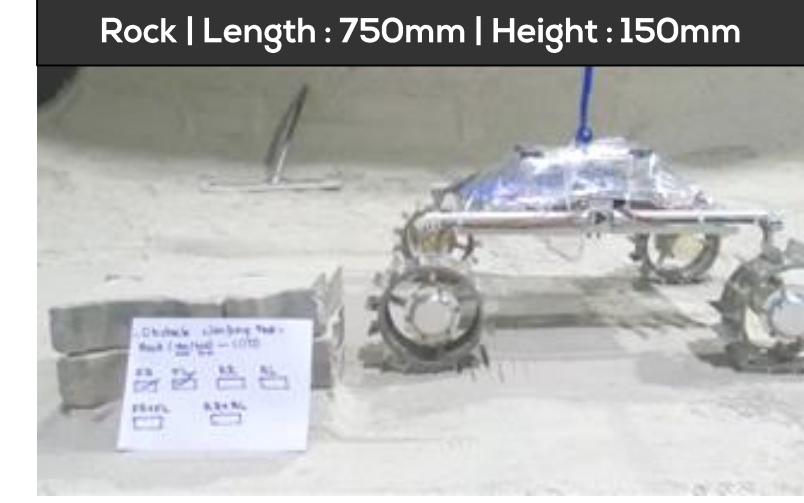
Gravity offset for Locomotion Testing



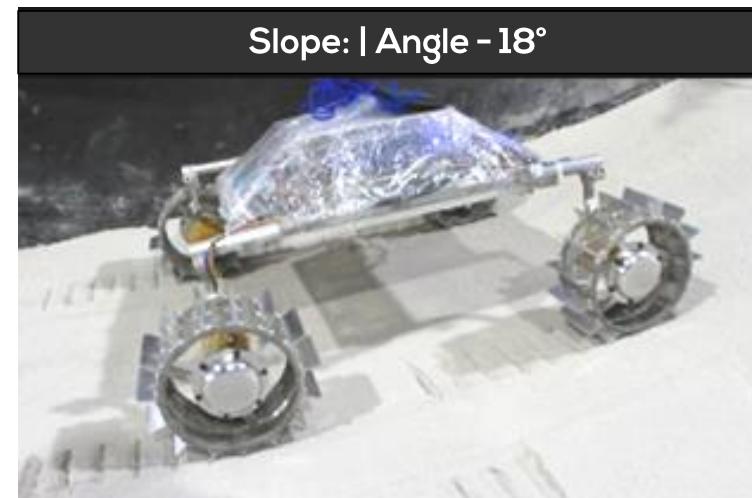
Crater | Dia : 750 mm | Depth : 150 mm



Rock | Length : 750mm | Height : 150mm



Slope: | Angle - 18°

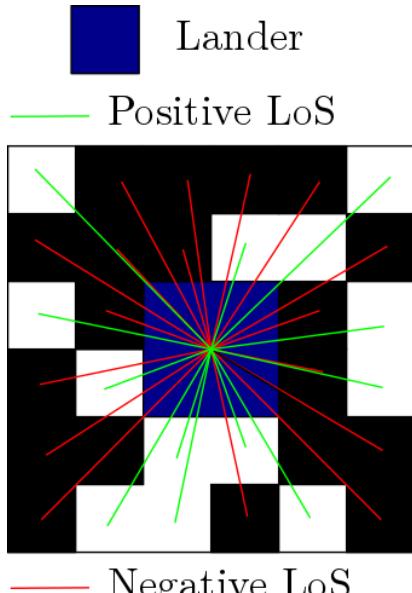
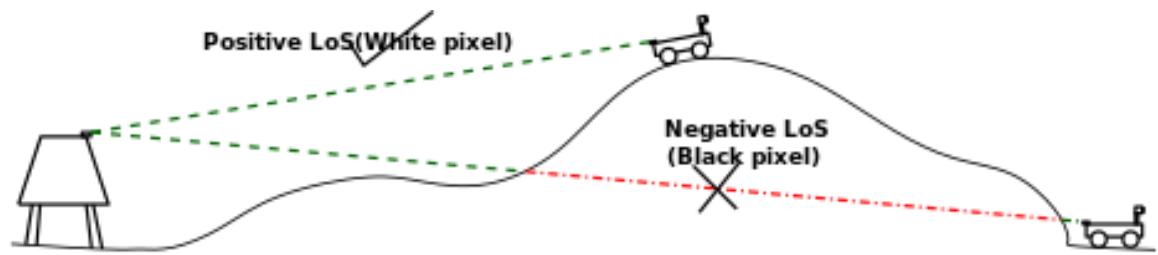


Point steer

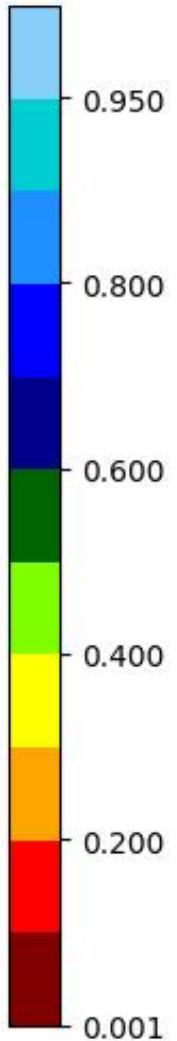
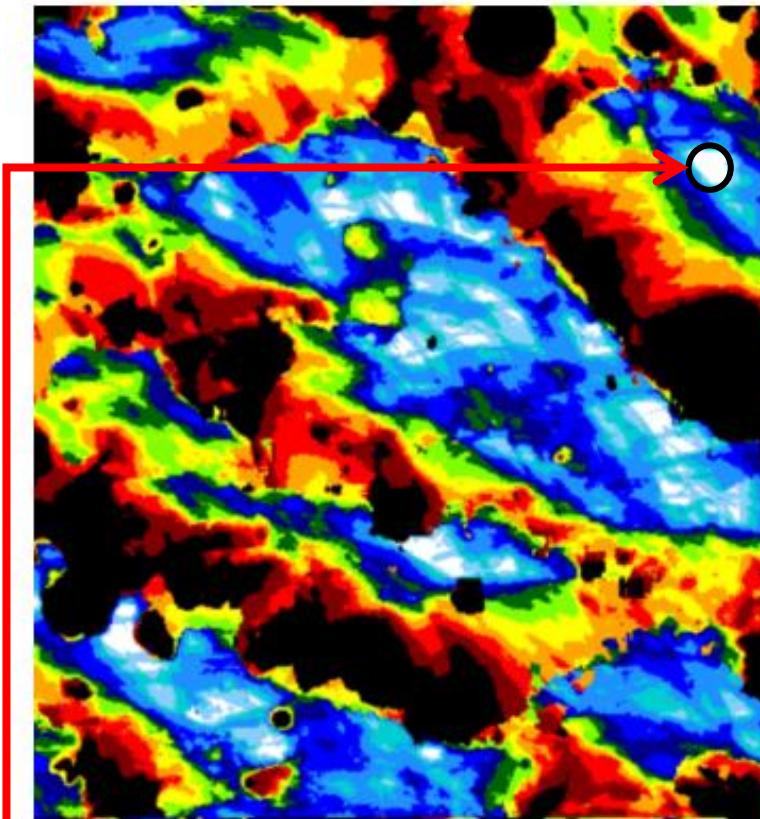




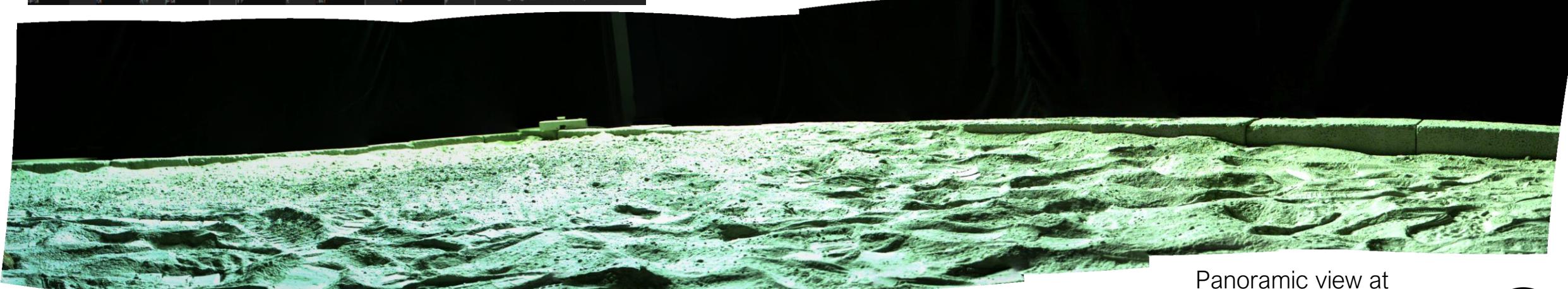
Terrain Analysis for Rover Ops



100% reachability
to 500m



The screenshot displays the 'OPERATOR COMMAND' interface for the TEAM INDUS MOONSHOT mission. At the top, there are six sets of command buttons labeled 'SET_HCD_PARAMS' with IDs 3 through 8. Each set includes a timestamp from 23/11/2017 10:30:00. Below these are two large 3D maps showing a terrain surface. On the right side of the screen, there is a vertical stack of controls: a compass rose, a vertical slider for 'Altitude' (0m to 200m), a horizontal slider for 'Elevation' (0m to 200m), and a button labeled '+ Compass Command'. At the bottom, there are three tabs: 'Radar', 'Review', and 'House Keeping'. The 'Radar' tab is active, showing a grid of data points. The 'Review' tab shows a timeline with markers for 'LAST IN THE STATE' and 'LAST IN THE STATE'. The 'House Keeping' tab shows a table of parameters like 'CAM LEFT 1 RPM' and 'CAM LEFT 1 TV'.



Panoramic view at Indus Lunar testbed



Payloads & Experiments

MoonLIGHT2

Use Lunar Laser Ranging to study the Earth–Moon system for gravitational physics, geodesy, and studies of the lunar interior.

LUCI

Lunar Ultraviolet Cosmic Imager: One of the few UV telescopes to perform astronomical observations from beyond LEO.

InSTEM

Test the regenerative and chemotactic properties of Planaria flatworms on the Moon.

KillaLAB (Peru)

Use extremophile Cyanobacteria to observe the effect of UV and cosmic radiation on them.

Space4Life (Italy)

Use extremophile Cyanobacteria to examine its effectiveness as a radiation shield.

Biocon Team ZΩI (India)

Examining the possibility of photosynthesis using extremophiles Cyanobacteria on the lunar surface for terrestrial life to exist on celestial bodies.

TeamEARS (India)

Demonstrate electrostatic deflection of charged particles to create a radiation shield for spacecraft or lunar habitats.

LunaDome (UK)

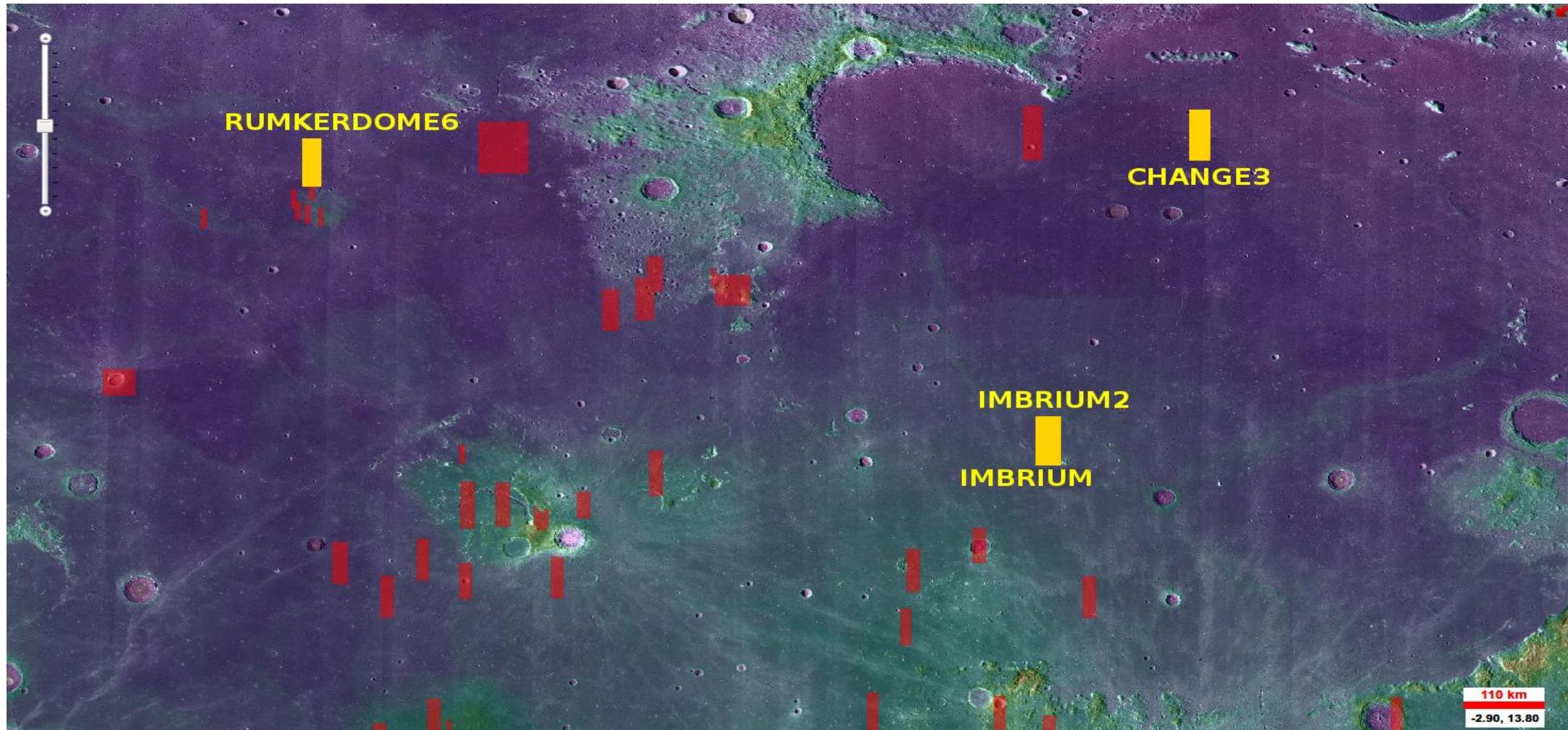
Inflate & sustain earth-like atmosphere in a 300mm dome for one lunar day

Team Callisto (India)

Study magnetic properties of lunar dust to examine its effects on the future of energy production on the Moon.



Candidates with LROC SDNTMs



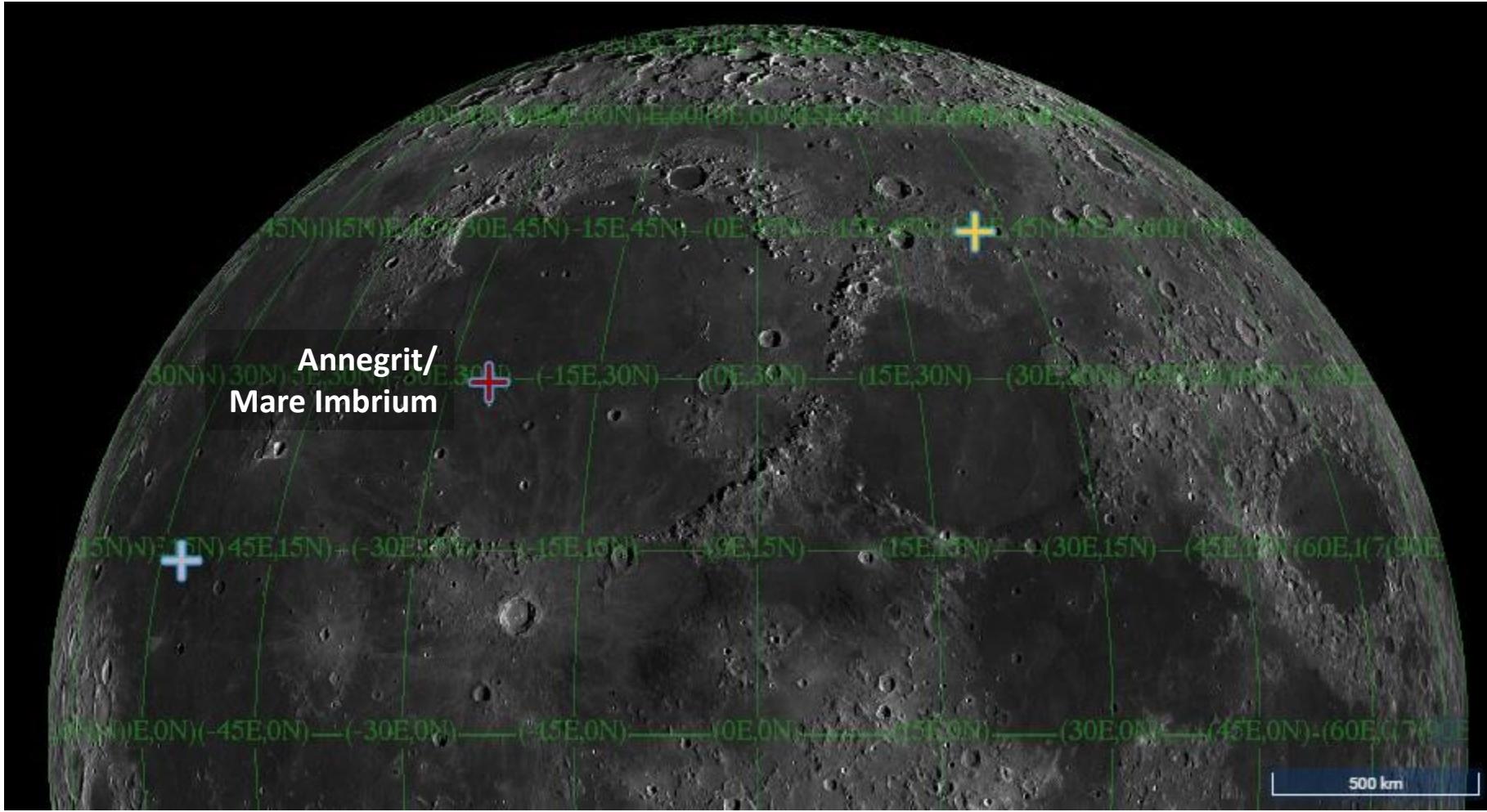
DTMs available (red) & evaluated (yellow)

Credits: PDS Node/WUSTL/ASU/LROC/LRO





Landing Site



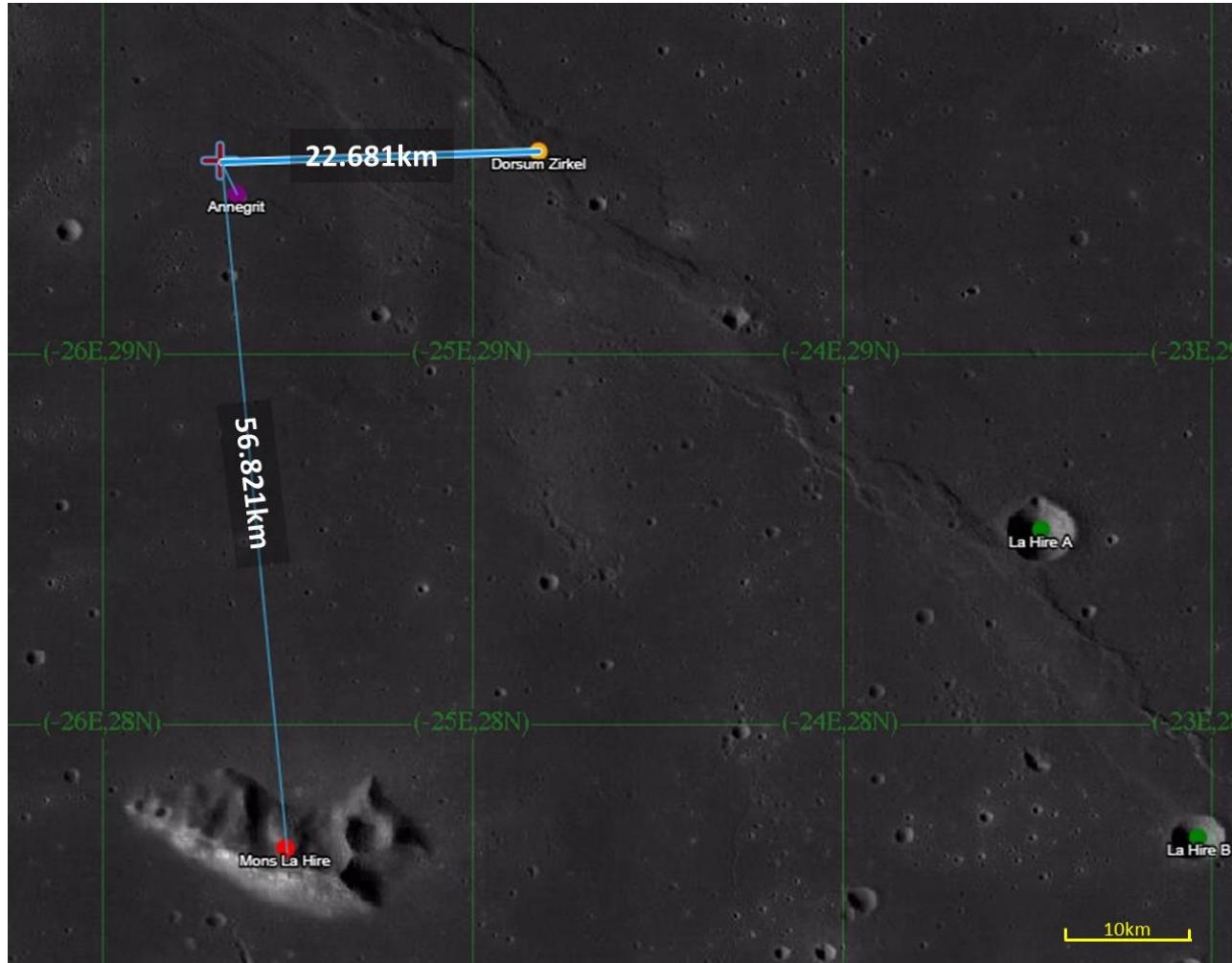
Annegrit @Mare Imbrium (29.52°N 25.68°W)

Credits: TARGET/ASU/LROC/LRO

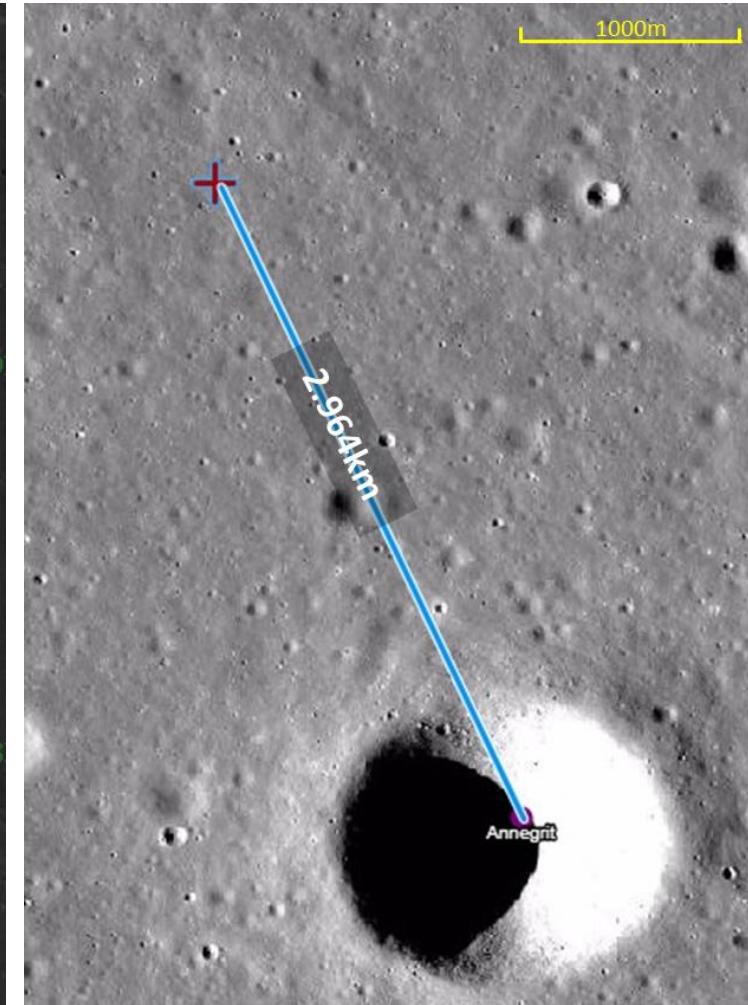




Annegrit



North of Mons La Hire, West of the Wrinkle Ridge of Dorsum Zirkel



~3km from Annegrit crater
Credits: TARGET/ASU/LROC/LRO



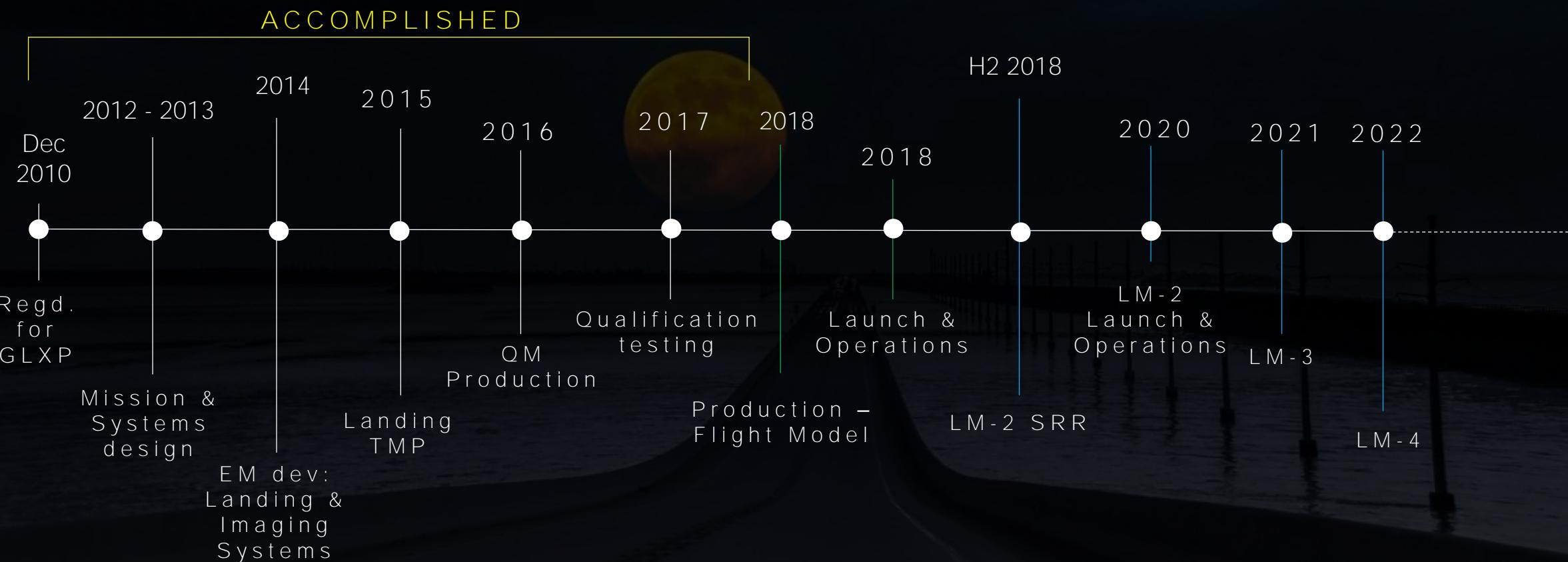


Image Credit: Naveen Gunda



Thank You

Aspire . Believe . Create

www.TeamIndus.in
info@teamindus.in

